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(54) Volume holographic data storage system

(57) A volume data storage system (200) for storing a plurality of holograms, where the storage system (200) comprises a coherent light beam source (210) and means (240) for splitting the coherent light beam into a reference beam and a signal beam. The storage system (200) also includes a storage device (260) which includes a base, having a top surface (261) and N number of storage media (262 to 266), where N is a positive integer. Each of the storage media (262 to 266) are made of photorefractive material, and they are mounted on the top surface (261) of the base. The signal and the reference beams are directed to a cross point formed where the two beams intersect, and the storage device is controlled by a controller (292) so that each of the storage media sequentially aligns with the cross point. The storage device may take the form of a disk (260) which may be rotatable about an axis perpendicular to the top surface of the base, and means for modulating the signal beam into data in the form of pages may also be provided.

FIG. 2

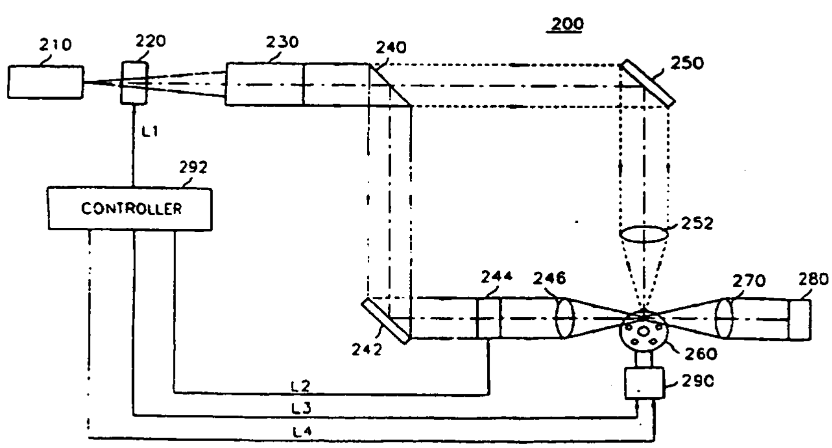

FIG. 3A

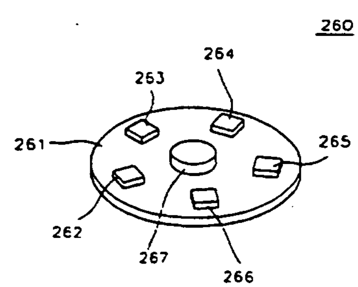

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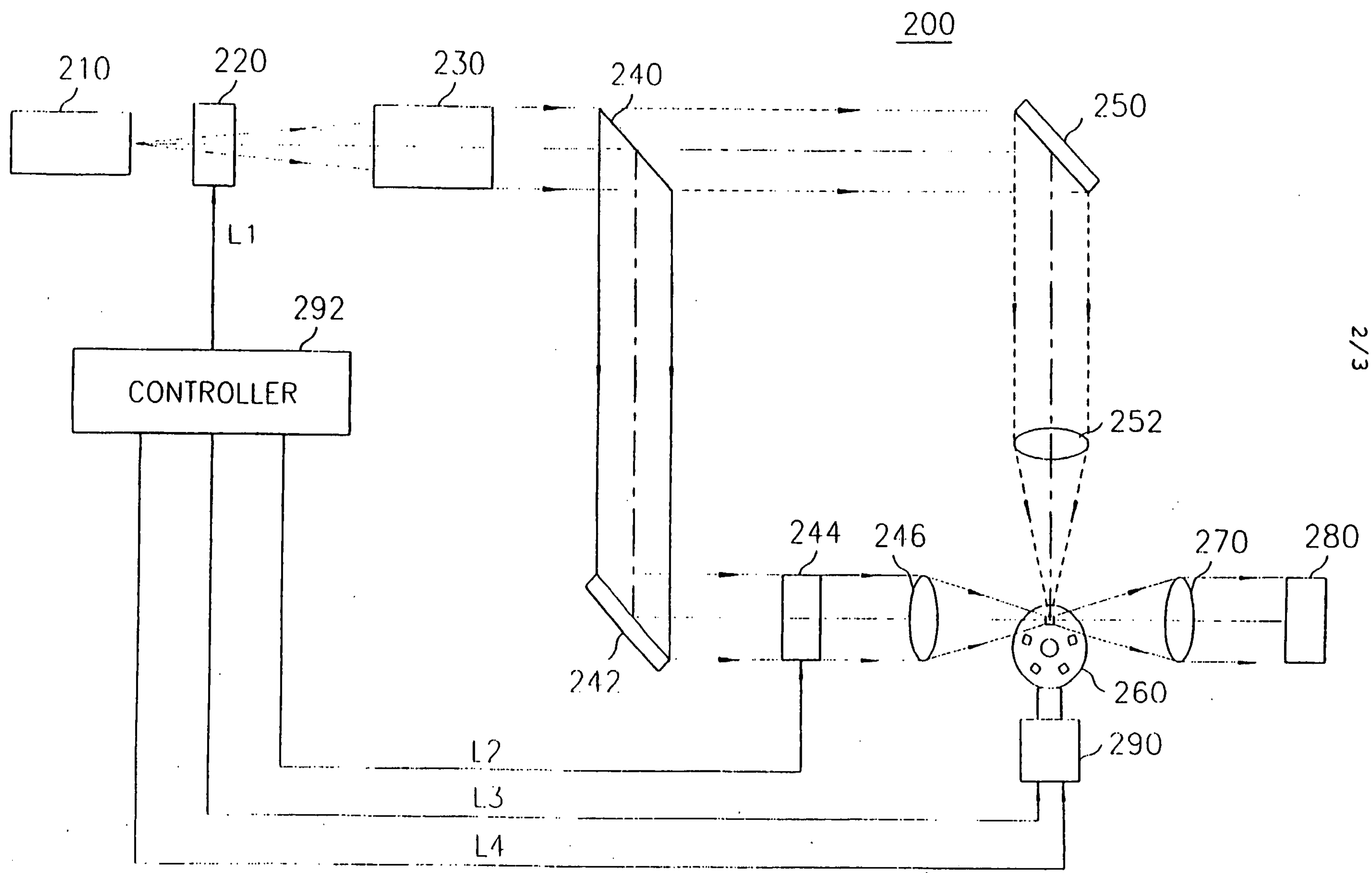
FIG. 2


200
210
220
230
240
242
244
246
250
252
260
270
280
290
292
CONTROLLER
L1
L2
L3
L4

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VOLUME HOLOGRAPHIC DATA STORAGE SYSTEM

The present invention relates to a volume holographic data storage system; and, more particularly, to a volume holographic data storage system incorporating therein a storage device mounted thereon a plurality of storage media for increasing the amount of holograms to be stored thereinto.

As is well known, demands for optically storing a large amount of data, such as a motion picture film, have been increasing. Therefore, various types of volume holographic data storage(VHDS) systems incorporating therein a storage medium have been recently developed for realizing high density optical storage capabilities, wherein the storage medium is conventionally made of lithium niobate($LiNbO_3$) or strontium barium niobate($Sr_xBa_{1-x}Nb_2O_6$) and is used for three-dimensionally storing the data in the form of pages.

In Fig. 1, there is shown a prior art volume holographic data storage(VHDS) system 100 capable of storing multiple holograms. The VHDS system 100 comprises a laser 110, a beam splitter 120, a first and a second mirrors 130, 132, a spatial light modulator(SLM) 140, an object lens 150, a storage medium

refractive index changes in response to the interference pattern to thereby record the modulated signal beam into the recording area 162 of the storage medium 160. If another page of data to be modulated by the SLM 140 is recorded on another recording area 162 of the storage medium 160, the VHDS system 100 can record the data by using an angular or a spatial multiplexing.

To read the stored data, the modulated signal beam retrieved from the storage medium 160 enters the CCD 170 which is capable of detecting the power of the retrieved signal beam. The retrieved signal beam is generated by diffraction of the reference beam from the storage medium 160.

In the above-described VHDS system 100, as the amount of holograms to be stored into the storage medium 160 increases, the volume of the storage medium 160 becomes larger to provide a lot of recording areas for an angular multiplexing or a spatial multiplexing. However, it is very difficult to produce a large volume of the storage medium 160 such as a photorefractive crystal without containing any defect or foreign material therein. In case that a defect or a foreign material is contained in the storage medium 160, it may generate a scattering noise or a distortion noise in the holograms, thereby making the reproduction of the holograms difficult.

Fig. 1 represents a perspective view of the prior art volume holographic data storage system;

Fig. 2 shows a schematic cross-sectional view of the inventive volume holographic data storage system; and

Figs. 3A and 3B present an enlarged perspective and an enlarged plan views of the inventive storage device incorporated thereinto a plurality of storage media shown in Fig. 2, respectively.

There are illustrated in Figs. 2 and 3 various views of the inventive volume holographic data storage(VHDS) system in accordance with preferred embodiments of the present invention.

There is illustrated in Fig. 2 a schematic cross-sectional view of an inventive volume holographic data storage(VHDS) system 200, capable of three-dimensionally storing a plurality of holograms into M number, e.g., 5, of storage media 262-266 in a storage device 260 as shown in Fig. 3A, wherein M is a positive integer. The VHDS system 200 incorporated therein the inventive storage device 260 comprises a light source 210 for generating a coherent light beam, a shutter 220, a beam expander 230, a beam splitter 240, a first and a second mirrors 242, 250, a spatial light modulator(SLM) 244, a first and a second lenses 246, 270, a

liquid crystal light valve, by the first mirror 242 to thereby image the signal beam onto the SLM 244. The SLM 244 includes discrete modulating regions, e.g., an array of T x S modulating pixels, T and S being positive integers, respectively. Each of the T x S modulating pixels is controlled by a voltage applied thereto through an integrated circuit(not shown), whereby the SLM 244 controls an amplitude and a phase of the signal beam impinged onto each of the T x S modulating pixels. Therefore, the SLM 244 is capable of converting the signal beam impinged thereonto into a modulated signal beam which carries data in the form of pages after passing therethrough. If 1st input data is inputted to the SLM 244, the 1st modulated signal beam is focused on the 1st recording area of the 1st storage medium 262 by the first lens 246.

As shown in Fig. 3A, there is shown an enlarged perspective of the inventive storage device 260 incorporated thereinto a plurality of storage media shown in Fig. 2. In the preferred embodiment of the present invention, the storage device 260 includes a base 261 having a top surface in the form of a circular disk, five storage media 262-266 and a blocking member 267. The storage media 262-266 are mounted on the top surface of the base 261, angularly separated from each other by an angle of ß degrees as shown in Fig. 3B. Each of the storage media 262-266 is made of a photorefractive crystal such as lithium niobate($LiNbO_3$). For example, each of

signal beam into the 1st recording area of the 1st storage medium 262. The 1st recording area is defined by an area of the 1st storage medium 262 where the reference signal beam overlaps with the 1st modulated signal beam.

The 1st modulated signal beam transmitted through the 1st storage medium 262 enters into the second lens 270, wherein the second lens 270 makes the modulated signal beam be parallel after passing therethrough. The modulated signal beam impinges onto the CCD 280 which is capable of detecting a distribution of light beam such as an image in the form of a page.

If another page of data, i.e., 2nd input data, to be modulated by the SLM 244 is recorded into a 2nd recording area of the 1st storage medium 262, the controller 292 generates a control signal and sends it to the SLM 244 via a line L2 for modulating the 2nd input data and to the shutter 220 for controlling the exposure time of the coherent light beam via a line L1. And also, the controller 292 generates a first motor signal and send it to the motor 290 via a line L3. In response to the first motor control signal, the motor 290 sequentially rotates the storage device 260 by an angle of a predetermined degrees, e.g., α, about an axis perpendicular to a plane which includes the reference and the signal beams after the 1st input data is recorded, thereby the 2nd recording area being aligned with the reference beam and the focal points of the first lens 246 and the beam imaging lens

While the present invention has been described with respect to the preferred embodiments, other modifications and variations may be made without departing from the scope of the present invention as set forth in the following claims.

4. The storage system according to any one of claims 1 to 3, wherein the plane is parallel to the top surface of the base.

5. The storage system according to any one of claims 1 to 4, further comprising means for modulating the signal beam into data in the form of pages.

6. The storage system according to any one of claims 1 to 5, wherein the controlling means includes a motor and a controller for controlling the motor, wherein the controller generates a first and a second control signals based on the data inputted to the modulating means.

7. The storage system according to claim 6, wherein, if the controller sends the first control signal to the motor, the motor rotates the storage device about an axis by an angle of α degrees, wherein the axis is perpendicular to the plane.

8. The storage system according to claim 6 or 7, wherein, if recording on one of the storage media is finished, the controller sends the second control signal to the motor to rotate the storage device about the axis by an angle of β degrees.

9. The storage system according to claim 7 or 8, wherein the

15. A storage device for use in a volume holographic data storage system, the storage device comprising:

a base having a top surface;

N number of storage media, each of the storage media being mounted on the top surface of the base and made of a photorefractive material, N being a positive integer; and

means for rotating the base about an axis perpendicular to the top surface of the base.

16. The storage device according to claim 15, wherein each of the storage media is angularly separated by an angle of ß degrees.

17. A storage device for storing a plurality of holograms constructed and arranged substantially as herein described with reference to or shown in Figs. 3A and 3B of the accompanying drawings.